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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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SCHMEISER, OLSEN + WATTS 3 LEAR JET LANE SUITE 201 LATHAM, NY 12110			EXAMINER CHEN, ERIC BRICE	
			ART UNIT 1765	PAPER NUMBER

DATE MAILED: 01/26/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

**Office Action Summary**

Application No.

10/711,953

Applicant(s)

CLINE ET AL.

Examiner

Eric B. Chen

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 05 December 2005.  
2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.  
3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-16 and 18-20 is/are pending in the application.  
4a) Of the above claim(s) 18-20 is/are withdrawn from consideration.  
5) ☒ Claim(s) 14-16 is/are allowed.  
6) ☒ Claim(s) 1-2 and 12-13 is/are rejected.  
7) ☒ Claim(s) 3-11 is/are objected to.  
8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.  
10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).  
11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☐ All b) ☐ Some \* c) ☐ None of:  
1. ☐ Certified copies of the priority documents have been received.  
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.  
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |  |   |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892)   | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____  |

## DETAILED ACTION

### ***Claim Rejections - 35 USC § 103***

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

3. Claims 1, 2, 12, and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Liu et al. (U.S. Patent No. 6,380,095), in view of Flander et al. (U.S. Patent No. 6,653,734).

4. As to claim 1, Liu discloses a method for forming semiconductor structures, the method comprising the steps of: (a) forming a first plurality of deep trenches (603) (column 11, lines 24-26), wherein forming each trench of the first plurality of deep trenches includes the steps of: (i) providing a semiconductor substrate (602) (column

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11, line 30; Figure 6), (ii) forming a hard mask layer (608/606/604) on top of the semiconductor substrate (602) (column 11, lines 24-27), (iii) etching a hard mask opening in the hard mask layer so as to expose the semiconductor substrate to the atmosphere through the hard mask layer opening, wherein the step of etching the hard mask opening comprises the step of etching a bottom portion of the hard mask opening according to a first set of etching parameters (column 11, lines 45-60; column 2, lines 23-26), (iv) etching a deep trench in the substrate via the hard mask opening (column 11, lines 59-67; column 2, lines 26-29). Although Liu does not expressly disclose processing a plurality of trenches, semiconductor fabrication inherently involved the simultaneous processing of multiple devices. See Streetman, *Solid State Electronic Devices*, Prentice Hall (1990), page 332.

5. Liu does not expressly disclose Applicants' steps (b) and (c). However, Liu teaches that the lateral etching of the overlying hard mask layers can cause the taper of the trench to deviate from the specified angle range (column 8, lines 47-54). Liu further teaches that volumetric gas ratio and other etching parameters can be varied (column 5, lines 22-48) to reduce erosion of the patterned mask (column 5, lines 17-22). Moreover, Liu teaches, by disclosing that volumetric gas ratio and etching parameters may be varied, that changing volumetric gas ratio and etching parameters appear to reflect a result-effective variable which can be optimized. See MPEP § 2144.05 (II). Volumetric gas ratio and etching parameters can be varied accordingly, depending on the desired outcome of the etching step, such as sidewall profile. Applicants' steps (b) and (c) appear to be an optimization step. Therefore, it would have been obvious to one of

ordinary skill in the art at the time the invention was made to: (b) determine the first yield of the first plurality of deep trenches; and (c) if the first yield of the first plurality of deep trenches is not within a pre-specified range of a target yield, forming a second plurality of deep trenches, wherein each trench of the second plurality of deep trenches is formed by using steps (a)(i) through (a)(iv), except that the step of etching the bottom portion of the hard mask opening is performed according to a second set of etching parameters, wherein the second set of etching parameters are adjusted from the first set of etching parameters such that, for each trench of the second plurality of deep trenches, a side wall of the bottom portion of the hard mask opening is more vertical than that corresponding to a trench of the first plurality of deep trenches. One who is skilled in the art would be motivated to optimize through routine experimentation of volumetric gas ratio and etching parameters. See MPEP § 2144.05 (II). Moreover, Flander teaches that faceting on the walls of hard mask layer (104) can result in an undesirable enlargement of the trench to be etched (column 4, lines 47-60; Figure 4). One who is skilled in the art would be further motivated to select an etching composition that produces the desired angle range, such as optimizing Liu's etching steps to produce a smooth hard mask layer sidewall.

6. As to claim 2, Liu does not expressly disclosed Applicants' claimed limitation. However, Liu teaches that the lateral etching of the overlying hard mask layers can cause the taper of the trench to deviate from the specified angle range (column 8, lines 47-54). Liu further teaches that volumetric gas ratio and other etching parameters can be varied (column 5, lines 22-48) to reduce erosion of the patterned mask (column 5,

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lines 17-22). Moreover, Liu teaches, by disclosing that volumetric gas ratio and etching parameters may be varied, that changing volumetric gas ratio and etching parameters appear to reflect a result-effective variable which can be optimized. See MPEP § 2144.05 (II). Volumetric gas ratio and etching parameters can be varied according, depending on the desired outcome of the etching step, such as sidewall profile.

Applicants' claimed limitation appears to be an optimization step. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to: determine a second yield of the second plurality of deep trenches; and if the second yield of the second plurality of deep trenches is not within the pre-specified range of a target yield, forming a third plurality of deep trenches, wherein each trench of the third plurality of deep trenches is formed by using steps (a)(i) through (a)(iv), except that the step of etching the bottom portion of the hard mask opening is performed according to a third set of etching parameters, wherein the third set of etching parameters are adjusted from the second set of etching parameters such that, for each trench of the third plurality of deep trenches, a side wall of the bottom portion of the hard mask opening is more vertical than that corresponding to a trench of the second plurality of deep trenches. One who is skilled in the art would be motivated to select an etching composition that produces the desired taper, such as altering Liu's first etching step which influences lateral etching of the hard mask layer. One who is skilled in the art would be motivated to optimize through routine experimentation of volumetric gas ratio and etching parameters. See MPEP § 2144.05 (II). Moreover, Flander teaches that faceting on the walls of hard mask layer (104) can result in an undesirable enlargement

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of the trench to be etched (column 4, lines 47-60; Figure 4). One who is skilled in the art would be further motivated to select an etching composition that produces the desired angle range, such as optimizing Liu's etching steps to produce a smooth hard mask layer sidewall.

7. As to claim 12, Liu discloses that the step of etching the bottom portion of the hard mask opening comprises the steps of: etching through a nitride layer (606) of the hard mask layer (column 11, lines 26-27, lines 45-60; column 2, lines 23-26; Figure 6); then etching through an oxide layer (604) of the hard mask layer (column 11, lines 27-28, lines 45-60; column 2, lines 23-26; Figure 6); and then etching through a portion of the semiconductor substrate (column 11, lines 59-67; column 2, lines 26-29).

8. As to claim 13, Liu discloses that the step of etching a top portion of the hard mask opening in a BSG layer (608) (column 11, lines 24-25) and an ARC layer (column 1, lines 47-49), wherein the top portion is above the bottom portion (Figure 6).

#### ***Allowable Subject Matter***

9. Claims 3-11 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

10. The following is a statement of reasons for the indication of allowable subject matter for claim 3: the prior art fails to teach or suggest that the second set of etching parameters are adjusted from the first set of etching parameters such that, for each trench of the second plurality of deep trenches, the step of etching the bottom portion of

the hard mask opening has a lower degree of anisotropy than that associated with the a trench of the first plurality of deep trenches. The closest prior art, Liu, teaches that the lateral etching of the overlying hard mask layers can cause the taper of the trench to deviate from the specified angle range (column 8, lines 47-54), and thus teaches away from isotropic etching (or etching with a lower degree of anisotropy) of the mask layer.

11. The following is a statement of reasons for the indication of allowable subject matter for claims 6: the prior art fails to teach or suggest that the bottom portion of the hard mask opening has a greater lateral width than a top portion of the hard mask opening. The closest prior art, Liu, suggests that the hard mask opening is either uniform (Figures 5-6) or that the top portion of the hard mask opening has a greater lateral width than a bottom portion of the hard mask opening (Figures 3-4).

12. The following is a statement of reasons for the indication of allowable subject matter for claim 7: the prior art fails to teach or suggest wherein, in the formation of the first plurality of deep trenches, a first side wall of the bottom portion of the hard mask opening associated with the nitride layer has a first height, wherein, in the formation of the second plurality of deep trenches, a second side wall of the bottom portion of the hard mask opening associated with the nitride layer has a second height, and wherein the first height is greater than the second height. The closest prior art, Liu, teaches a silicon nitride layer of a single thickness of 2,200 Å (column 11, line 27). However, there is no motivation or suggestion of varying the thickness of the silicon nitride layer.

13. Claims 14-16 are allowed.



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14. The following is an examiner's statement of reasons for allowance for claim 14: the prior art fails to teach or suggest that the bottom portion of the hard mask opening has a greater lateral width than a top portion of the hard mask opening. The closest prior art, Liu, suggests that the hard mask opening is either uniform (Figures 5-6) or that the top portion of the hard mask opening has a greater lateral width than a bottom portion of the hard mask opening (Figures 3-4). However, there is no motivation or suggestion that the bottom portion of the hard mask opening has a greater lateral width than a top portion of the hard mask opening, as in the context of claim 14.

15. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

### ***Response to Arguments***

16. Applicants' arguments (Applicants' Remarks, pages 9-10), filed Dec. 5, 2005, regarding the rejection of claim 1 under 35 U.S.C. 103(a) as being unpatentable over Liu, in view of Flanner, have been fully considered, but they are not persuasive. Applicants' newly added claim limitations of "determining a first yield of the plurality of deep trenches" and "if the first yield is not within a pre-specified range of a target yield" using "a second set of etching parameters... adjusted from the first set of etching parameters" appears to be the routine optimization of etching parameters. Liu teaches that volumetric gas ratio and other etching parameters can be varied (column 5, lines

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22-48) to reduce erosion of the patterned mask (column 5, lines 17-22). Thus, adjusting the etching parameters, including changing volumetric gas ratio and etching parameters as taught by Liu, appear to reflect a result-effective variable which can be optimized.

See MPEP § 2144.05 (II).

17. Applicants' arguments (Applicants' Remarks, pages 10-12), filed Dec. 5, 2005, regarding the rejection of claims 2, 12, and 13 under 35 U.S.C. 103(a) as being unpatentable over Liu, in view of Flanner, have been fully considered, but they are not persuasive, as discussed above.

18. Applicants' arguments, (Applicants' Remarks, pages 10-11), filed Dec. 5, 2005, with respect to the rejection of claim 14 under 35 U.S.C. 103(a) as being unpatentable over Liu, in view of Flanner, have been fully considered and are persuasive. The Liu reference does not teach or suggest the claim limitation of "that the bottom portion of the hard mask opening has a greater lateral width than a top portion of the hard mask opening" (page 12). The rejection of claims 14-16 has been withdrawn.

### ***Conclusion***

19. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within

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TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Eric B. Chen whose telephone number is (571) 272-2947. The examiner can normally be reached on Monday through Friday, 8AM to 4:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine G. Norton can be reached on (571) 272-1465. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

EBC  
Jan 18, 2006

*EBC*

EXAMINER  
*Nadine Norton*